dioxide as in common air, and well developed green gourd leaves, were tried. The gourd leaves, which contained starch at the beginning, entirely lost it within a day or two in the atmosphere deprived of carbon-dioxide, while those in the other shade remained still full of it. The shades, and the contents of the dishes, were then changed, so as to bring the starchless leaves into the shade containing carbon-dioxide. During the day these became again full of starch; while within twenty-four hours it had quite disappeared from the leaves in the other shade. In a similar experiment with sugar-beet the control plant in the open air was covered with a black paste-board box, and it was found that the leaves in the shade deprived of carbon-dioxide lost their starch at about the same rate as those in the dark. In no case was starch found in the leaves while they remained in an atmosphere without carbon-dioxide.

The second set of experiments was made with long leaves of bulrush and bur-reeds, which were etiolated, and then separated from the plants. With the same general precautions as before, the upper end of the leaf was inserted in the shade without carbon-dioxide, the lower in an atmosphere containing five per cent. of carbon-dioxide, whilst the space between was left free to the open air. This intermediate part was obscured by tin-foil, so that no starch could be formed in it at the expense of any carbon-dioxide passing through the tissues from the lower shade; and it was supposed that if such a phenomenon were possible, the spacious longitudinal air channels of these plants might be especially favourable to the transmission of the gas. These experiments usually lasted one day, and uniformly gave the same result; starch was formed abundantly where carbon-dioxide was at disposal in the air, while the excess of it in the lower shade had no effect upon the portion of leaf in the upper shade, which remained entirely free from starch.

The apparatus when arranged was always placed in a light window, shaded by gauze blinds if the sun were too hot; and in these latter experiments it was an interesting circumstance that, in the lower portions of these rather thick leaves, more starch was formed on the side next to the window; therefore, in two cases a piece of looking-glass was placed behind the shade, when, being equally illuminated, starch was formed in equal abundance on both sides of the leaf. This variation in the starch-formation, according to the amount of light, showed that that portion of leaf had not always used all the carbon-dioxide at its disposal, and that consequently there was an excess which might have passed upwards through the tissues.

The third set varied from these in having no part of the leaf exposed to free air, thus obviating the possibility of the carbon-dioxide being diffused into it in passing upwards through the plant. A glass vessel containing air without carbon-dioxide was placed within a large shade containing air with 5 per cent. of this gas; and a previously etiolated leaf, with its stem in water, was so fixed as to be partly in the one and partly in the other. After six or eight hours it was examined for starch. Without exception starch was formed abundantly in the parts in the large shade, whilst no trace of it was found in those in the inner vessel even quite close to the junction between the two.

The remaining two sets of experiments were made to ascertain whether starch formation in leaves, in the open air, is accelerated by giving an excess of carbon-dioxide, either to adjoining parts of the leaves themselves, or to the roots. In the first case leaves separated from the plant were divided lengthways. One half, with the stalk in water, was in a shade with air containing 5 per cent. of carbon-dioxide, its upper part projecting under the glass lid of the shade, which was luted with grease, into the open air. The other half of the same leaf was laid on the lid, on filter paper soaked with boiled water to keep it moist, and put as near as possible to the projecting piece of leaf. In the other cases etiolated leaves, organically united with plants whose roots were in rich humus soil, were divided lengthways; one half, quite cut off, was laid near to the other, and the two were examined and compared after some hours' exposure in sunlight. The results of both these sets of experiments were uniformly the same; careful examination showed that starch was formed as readily and plentifully in those portions of leaves excluded from any other source of carbon-dioxide than that in the air surrounding them, as in those having an excess of it at command.

From these experiments Dr. Moll concludes that starch is never formed in leaves in an atmosphere deprived of carbon-dioxide, however much of it may be at the disposal of the other, under- or above-ground, parts of the plant; nor can starch-formation be accelerated in one part of a leaf by an excess of carbon-dioxide being at the disposal of another part of it, either in the air, or through the roots.

The results of these elaborate experiments are doubtless in accordance with the direction of those of other modern inquirers on this subject. At the same time it will probably be felt, that, when long-accepted opinions, which many well-known facts seem to favour, are held to be called in question, we may still ask for further confirmation, before accepting as decisive, conclusions depending on the exact interpretation of experiments made with living organisms exposed to somewhat artificial conditions. It may be hoped, however, that this further instalment of evidence in a given sense will incite to further research.

OUR ASTRONOMICAL COLUMN

DE VICO'S COMET OF SHORT PERIOD.—It has been already remarked in this column that, according to Prof. Brünnow's last investigations relative to this comet, it appears necessary to admit a very material degree of uncertainty in the value of the mean motion determined from the observations of the year 1844, notwithstanding the comet was discovered on August 22, and followed till December 31, or for a period of more than four months, and, moreover, was observed with a degree of precision which has seldom been attained with these bodies. In Prof. Brünnow's masterly and elaborate discussion, "Mémoire sur la Comète elliptique de De Vico," which gained the prize offered by the Royal Institute of the Netherlands, in June, 1848, the planetary perturbations were calculated to the epoch of next return to perihelion in February, 1850, but in consequence of the computed positions showing that observation in that year would be quite hopeless, the calculation was continued with all possible precision to the ensuing perihelion passage early in August, 1855. The computed track in the heavens for this appearance was by no means an unfavourable one for observation; the comet would remain for a considerable period near the earth, being at its least distance on August 2, just before the perihelion passage, when it should have approached our globe, according to Prof. Brünnow's calculation, within 0·58 of the earth's mean distance from the sun. Nevertheless, it was not detected in this year—an object observed by M. Goldschmidt, not far from its track, in May, being certainly a distinct body, if the star of comparison was correctly identified. It was looked for repeatedly with the large refractors at Cambridge and Berlin. In 1860 again, ephemerides were prepared and a search was made, at least at the observatory of Harvard College, U.S., but ineffectually, indeed the chance of observing this comet when the perihelion passage falls in the winter must be but small.

The later results obtained by Prof. Brünnow, to which allusion is made above, will be found in No. 3 of his Ann Arbor *Astronomical Notices:* he there gives his reasons

for concluding that he had placed too great reliance upon the value of the mean motion determined in his memoir, and while obtaining a new value (about 650″) which would assign for the period of revolution in 1844 about 1994·0 days, he intimates the necessity of searching for the comet in future on the supposition that this period may be in error ± 30 days. At this distance of time or at the end of the sixth revolution since 1844, so great an amount of uncertainty of course renders the preparation of limited ephemerides useless, but it may be observed that the period finally deduced by Prof. Brünnow would bring the comet to perihelion again in the present summer, and it will certainly be worth while to keep a close watch upon those regions of the heavens which its path must traverse on this hypothesis; we might indeed expect, if the comet continues in the same condition as in 1844, that it would not escape detection, should the perihelion passage fall between the beginning of the present month and the middle or end of October. On July 14 its orbit is thus projected on the sky, the positions consequently indicating the line in which it should then be found according to the different suppositions as to the date of perihelion passage:—

Time from Perihelion.	Right Ascension.	Declination.	Distance from Earth.	Intensity of Light.
+ 40 days	60·3	+ 19·3	1·89	0·17
+ 10 ,,	43·0	+ 13·4	1·12	0·56
− 20 ,,	21·2	+ 3·0	0·64	1·68
− 40 ,,	350·1	− 13·6	0·39	4·02
− 50 ,,	321·6	− 24·8	0·34	4·78
− 60 ,,	289·3	− 30·1	0·38	3·60

While it is of importance that an effort should be made to recover the comet, now to all intents *lost*, in the present year, no surprise need be occasioned if the endeavour should prove fruitless. It is quite possible that the mean motion in 1844 was of such amount as would bring the comet, with the influence of planetary perturbation into so close a proximity to Mars at the end of August, 1866, as to occasion very material changes in the elements of its orbit; and again there is the possibility that, as Dr. von Asten suspects has been the case with Encke's comet, it may have encountered one of the minor planets, and with the result of a sensible change in its motion.

And it is to be borne in mind to whatever cause or causes the circumstance may be due, that De Vico's comet has been shown by M. Le Verrier and Prof. Brünnow to be with great probability identical with the comet of 1678 observed by Lahire at Paris; yet in the long interval from 1678 to 1844 there is no record of a comet which can be identified with it, and in the early part of its appearance in the latter year it was visible to the unassisted eye. It does appear strange that in the days of Messier and Pons the comet should have escaped detection at one or other of its returns.

While writing on De Vico's comet we may mention that in heliocentric longitude 339°·6 this body approaches very near to the orbit of the periodical comet of D'Arrest, of which observations may be expected in the present year. The distance is within 0·0055 of the earth's mean distance from the sun, or about 507,000 miles, rather more than twice the moon's distance from the earth, but it does not appear likely that there has been any actual close approach of the two comets during the last fifty or sixty years.

THE LATE PROFESSOR HEIS.—We regret to record the sudden death of Prof. Edward Heis, the well-known German astronomer, which occurred on June 30 from an attack of apoplexy. Prof. Heis was born in 1806, completed his studies at Bonn in 1827, and received in 1852 a call to the ordinary professorship of mathematics and astronomy at the Royal Academy of Münster, Westphalia, which he filled until the time of his death. He was a most diligent and accurate observer in the particular branches of astronomical research to which he devoted himself. His "Atlas Cœlestis Novus" may be considered the standard work for magnitudes of the stars visible in central Europe, his acute vision enabling him to add a large number of stars of what he calls 6·7m. not included in Argelander's "Uranometria." While resident at Aix-la-Chapelle previous to his appointment to Münster he published the results of ten-years' observations upon shooting-stars which were carefully discussed. In 1875 appeared his observations on the zodiacal light, extending over the twenty-nine years, 1847-1875, and forming No. I. of *Publications of the Royal Observatory at Münster*; it is a most important addition to our collection of observations of this as yet little understood phenomenon. From 1858 to 1875 he edited the *Wochenschrift für Astronomie*, a periodical better known on the Continent than in this country. Prof. Heis was also the author of a collection of examples and problems in general arithmetic and algebra, which, we believe, has reached the forty-fifth edition in Germany. His observations of variable stars were conducted upon a system of extreme care, his researches in this direction being encouraged and guided by Argelander; he first established the variability of that irregular star ε Aurigæ, not without a long course of assiduous observation. He was an excellent draughtsman, and produced many fine pictures of nebulæ, though, unfortunately, supplied with very limited optical means.

THE CAXTON EXHIBITION

IT is not too much to say that Science has been advanced by the art of printing more than by any other of the world's inventions, for by it not only has the knowledge of scientific truth been spread throughout the world, but it has been perpetuated to all time, and the names of great heroes in science have been rendered immortal. Long after sculptured monuments, commemorative of the lives and work of great men have crumbled away, their written works remain, and the art of printing has contributed more than anything else to the bringing about of that result. The names of some of the greatest philosophers the world has ever seen would have had but a narrow and comparatively ephemeral celebrity, were it not for the record of their lives and writings which the productions of the printing press have preserved to them.

But great as have been the advantages which Science has derived from the printer's art, she has, in return, conferred as many and as important benefits upon the development of that art; and this is recorded in unmistakable language in the Caxton Collection, which, though (probably for want of space) very deficient as far as modern printing machines are concerned, constitutes a most interesting and instructive series of historical and typical forms, in which the rise and development of printing machinery may be traced from the early screw presses of wood used by Caxton and the early printers, through the Stanhope and lever presses of the last century, to the powerful steam machinery of the present day.

The principal aim of the designers of printing machinery has always been to obtain increased rapidity of working; and during the last fifty years this has been brought to an extraordinary degree of perfection. It was considered a wonderful feat when, in the year 1814, the celebrated König machine was started, throwing off 1,100 sheets of the *Times* newspaper per hour; but this number was doubled by König's second machine, which he brought out ten years after. In the year 1827, by means of Applegarth and Cowper's four-cylinder machine, the yield was raised to 5,000 per hour, and in 1848 the celebrated "Times" vertical machine was erected, which produced 12,000 single impressions per hour. The next advance was made by Richard Hoe, who, in 1857, introduced his cylinder machine into this country, where it was first